

A PAW Special Report

Psychic Process, Energy Transfer, and Things That Go Bump in the Night

ROBERT G. JAHN '51

TWO OF THE most celebrated joys of the academic lifestyle are the freedom to pursue any scholarly problem, no matter how irrelevant or far out it may seem at the time, and the impetus to do so provided by the perceptive, persistent, sometimes irreverent questions of the young students we are privileged to teach. Never in my career have these two benefits been more beautifully illustrated than in the case of the extraordinary topic of this report. Indeed, it is as much the flavor of light-hearted exploration of a very exotic field, hand-in-hand with an intelligent and dedicated undergraduate, as the substance of the field itself that I would like to share with you.

Late in the spring of 1977, Carol Kay Curry '79, an electrical engineering and computer science major from Pasco, Washington, came to me to ask whether she might undertake some independent work in psychic phenomena that would build upon her background and skills in instrumentation and data processing. Although I was well aware of the many times I have proudly spoken or written about the breadth and flexibility of the Princeton engineering curriculum, and the care with which we hand-tailor each undergraduate program to suit individual interests, the involvement of one of our students in psychic research seemed to me to strain even those generous guidelines.

In an attempt to table the issue, I asked, somewhat rhetorically, which faculty member could conceivably supervise this work, and Carol, with her characteristic bluntness, responded that, obviously, I would. With the dilemma thus compounded, but no retreat path left, I provisionally agreed, pending the results of a full summer of

On a rainy Monday night last April, more than 200 members of the Princeton community jammed into the Wilson School Auditorium to hear Dean of the Engineering School Robert G. Jahn '51 — normally noted for his work on advanced space propulsion systems — lecture on the unlikely subject of psychic research. More than an hour after the conclusion of his talk, many of them were still there, asking questions and offering comments on various aspects of the subject. Since then, he has been besieged with countless requests for transcripts of his remarks and for personal interviews by students, faculty, other workers in the field, and government officials. At the editors' suggestion, Jahn agreed to prepare this special report "in the hope that PAW's readers might share some of the fun we have had in this strange academic adventure." — Ed.

background research in the field. This she undertook with considerable zest, digesting and reporting an enormous amount of literature in the process. Together and separately we visited numerous laboratories around the country, attended several professional meetings, had discussions with various people here and elsewhere, and started a few experiments of our own. As the following academic year began, we agreed the project was worth pursuing.

That winter I happened to be on leave at Stanford, where more interest is shown in this field than at most universities. Carol was able to join me there for a few weeks, and together we talked with faculty and staff, and worked with a small research group at the nearby SRI International laboratory. A hastily convened, informal seminar just prior to our leaving the Stanford campus elicited unexpected interest and audience participation, and provided many more valuable contacts. Our more formal Farnum Lecture at Princeton in April 1978 likewise exposed an unanticipated interest in this community and led to the request for this report.

Thus, the impressions we now hold of the psychic world are mainly distilled from the past year and a half of study and light involvement with the subject, and we hope your reaction to our preliminary findings will be weighted accordingly. In particular, Carol and I wish to emphasize that we claim no authority in this field and take no position of advocacy. Indeed, we intend no judgment of any sort. Rather, we shall simply set before you some of the things we have seen and done, some of the people we have met, some of the thoughts we have shared, and let you assess them as you will.

Even this is a difficult task, for there are a great many threads that need to be woven together. We would like to begin by describing the remote viewing "credibility exercises" we undertook just to convince ourselves that there is some scholarly substance to the field. Then we will turn to our early experiments in the domain of psychokinesis, which has become our main interest. Finally, we will outline some of the analytical models that have been proposed for interpreting psychic phenomena, and discuss possible applications and implications of psychic process. Each of these threads is sufficiently strange to common experience that it must be handled rather carefully. To be sure, the field is still very much in its infancy, and to us, no one thread has proven entirely persuasive; only in the interweaving does a pattern seem to emerge, and it is that pattern which we hope to show you.

EARLY IN OUR STUDY, we had to make a basic choice of strategy: Should our work revolve around the talents of gifted psychics — people we would import specifically to generate the phenomena we would investigate — or should we focus on “do-it-yourself” experimentation, confining ourselves to those phenomena that could be produced more or less routinely by our own students and staff? For a number of reasons we chose the latter route. First, with a few exceptions, “blueblood” psychics tend to be difficult to schedule and work with in a disciplined, academic fashion. Second, involving students in the generation of the phenomena seemed at least as important as their passive study of it. Finally, we were persuaded that the greater significance of this field lies in what is, or could be, accessible to the general public — rather than in what a few gifted subjects can achieve — and one of our aims was to assess what that domain might be.

Having chosen this route, however, we then needed a “credibility exercise” — i.e., we had to establish that we were indeed capable of generating effects to study. At this point Carol came to me bearing an article from the *Proceedings of the Institute of Electrical and Electronic Engineers*, in which two physicists from SRI, Russell Targ and Harold Puthoff, claimed it was possible for relatively untrained persons to transmit significant amounts of information over long distances by a technique they called “remote viewing.”²⁵ Simply stated, the process involves an outbound experimenter who posi-

tions himself at a randomly selected “target” location at a prescribed time, and an inbound experimenter who attempts to visualize aspects of the scene in which his colleague is immersed. The authors reported remarkable anecdotal results and described attempts to quantify systematically information transferred by this procedure.

Because of its simplicity and immediate verifiability, Carol and I decided that this was the thing to try. For our first attempt, I took advantage of a visit to the Brookhaven National Laboratory near Stony Brook, Long Island, where at the appointed time I excused myself from a reception, sat out on the lawn, and sketched the scene I saw in front of me. Carol, who has never been to Brookhaven, was in Princeton baby-sitting at the time. Figure 1 shows my sketch (I will apologize only once for the quality of the art work): I was seated roughly in the lower-right corner, just beside the building labeled “dorm,” looking up the hill toward a row of trees on the ridge, a flag pole, and a water tower. On my right was a pine forest with some birds singing in it; on the left was a road with a car or two, and some people walking along the edge.

The sketch that Carol made is shown in Figure 2. You see that while the general flavor of the picture is somewhat different, there are interesting correlations of objects. For example, she has identified the tower, the cars, birds, trees, and the building behind me. Curiously, there is a right-left inversion in the composition of the

The History of Psychic Research

IN A SENSE, the study of psychic phenomena is one of the oldest of human endeavors.¹⁻⁶ As far back as can be traced, mortal man has pondered the supernatural in one form or another. Cave drawings at Lascaux and Altamira, circa 20,000 B.C., reflect this preoccupation, and the religious rites of early societies were heavily loaded with psychic formalisms. The golden civilizations of the Egyptians, Greeks, and Romans dealt extensively in psychic process: the Delphic Oracle was politically important from the earliest Hellenic times to the age of Alexander the Great, and was consulted on problems as diverse as the proper measures to stop a plague, the constitutions of Greek city-states, and the best locations for new colonies. Even Aristotle, one of the most empirical of the classical philosophers, studied the causal links in prophetic dreams.

The Bible, like most other basic theological texts, treats psychic process as a central ingredient, in a tone so matter-of-fact that one is inclined to believe that people in those times accepted such events rather routinely. Incidentally, the Bible is an excellent catalog of psychic phenomena; virtually every category that is identified today is illustrated there in one form or another.

Medieval writing abounds with supernatural allusion, and even in the renaissance period it is still difficult to separate psychic interest from religious dogma, although it was then transcribed into more organized forms in art and literature. In this country, colonial hysteria over witchcraft probably is indicative of more than simple religious paranoia, and a variety of more sanitary parlor exercises seem to have persisted throughout American history. Even Mary Todd Lincoln was in the habit of having séances in the White House during the 1860s.

Despite these millennia of human concern with the paranormal, the scholarly search for an understanding of psychic phenomena began only a century ago, with the establishment in London, in 1882, of the Society for Psychical Research, in whose proceedings appeared the first formal publications of controlled experiments in telepathy and clairvoyance.⁷⁻¹⁰ Three years later the counterpart organization in this country, the American Society for Psychical Research, was founded in Boston.

ing William James. Over the period 1912-18, Thomas W. Stanford, brother of the founder of Stanford University, gave and bequeathed well over \$500,000 specifically to endow the study of psychic research,¹¹ and to this day Stanford has a “Psychic Research Fellow.” Modest research programs were also undertaken at Harvard and a few European universities at about this time.¹²⁻¹⁴

In 1930, Professor William McDougall came from Oxford, via Harvard, to chair the psychology department at Duke University and there, along with two postdoctoral students, J. B. Rhine and Louisa Rhine, made Duke the center of academic research into psychic phenomena. In 1937 they began publication of the *Journal of Parapsychology*, which remains a leading journal in the field today. A professional organization calling itself the Parapsychological Association was formed in 1957, and was subsequently recognized by the American Association for the Advancement of Science. There are now seven English-language, professional journals in the field,¹⁵ many magazines and newsletters, and an increasing number of scholarly books published each year.

At Princeton, the history of psychic research is rather thin, but not entirely void. In the 1930s, Upton Sinclair, whose wife appears to have been a gifted psychic, wrote on her abilities in clairvoyance and telepathy, including a rather famous book called *Mental Radio*,¹⁶ and engaged in some dialogues with Albert Einstein on the credibility of psychic process. In 1937 our renowned Professor of Statistics Samuel Wilks found himself involved in a controversy over the validity of the statistical procedures of early psychic researchers, and published his own recommendations for methods that could be applied to telepathy experiments.¹⁷ In the 1950s, Hadley Cantril, then chairman of the Psychology Department, displayed some interest in parapsychology, especially in poltergeist phenomena, but apparently did not publish anything of substance in the field. At the present time, I am aware of some eight to ten faculty members in as many disciplines who have a substantial interest in psychic process, and there are many students who have expressed a desire to study and experiment in various aspects of it.

— R.G.J.

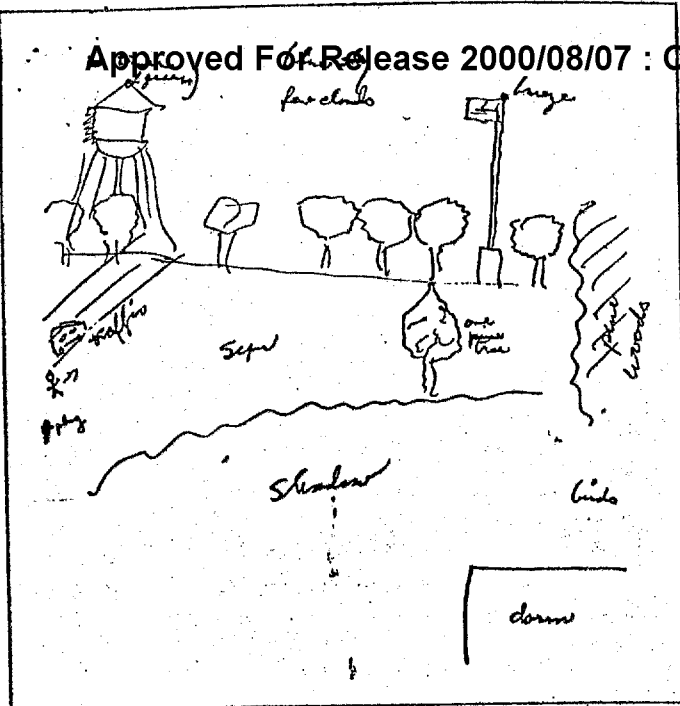


Figure 1

scene; most of the things that are on the right side of my sketch appear on the left of hers. Note also the comment on the right center of Carol's sketch indicating that at the beginning of the period she sensed I was facing up the hill toward the tower, but that five minutes later I turned around toward the building behind me. Although I had not thought to note it in my sketch, I had indeed done precisely that.

We were excited by this first attempt, and shortly thereafter we tried the process in reverse. On this occasion, I was in Pompano Beach, Florida, while Carol was in Princeton, and I attempted to be the percipient and she the outbound target. The scene I perceived, sketched in Figure 3, centered on Carol riding a horse. (That is a horse in the middle; it really has only four legs.) Details include some tall trees, a fence, a small road, and a strange object in the foreground I identified as a woodpile, old car, or shed. I noted that Carol dismounted eight minutes after the start of the period, and then walked the horse around holding the bridle.

Comparing this with Carol's sketch, shown in Figure 4, we find that she was indeed with a horse, not in a field of grass as I had it, but in an outdoor show ring. The fence was not the split-rail type I

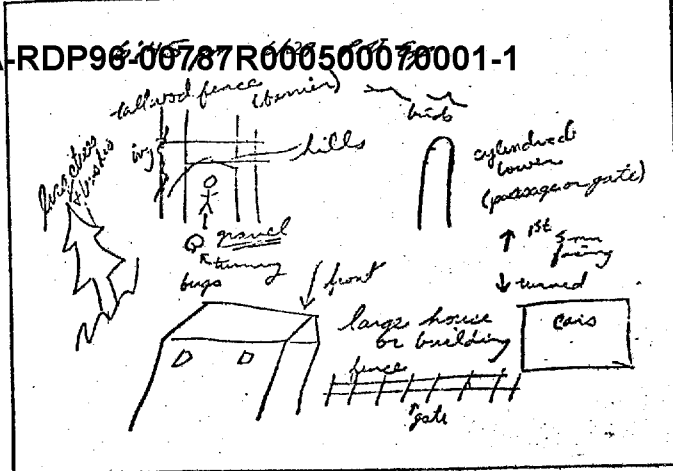
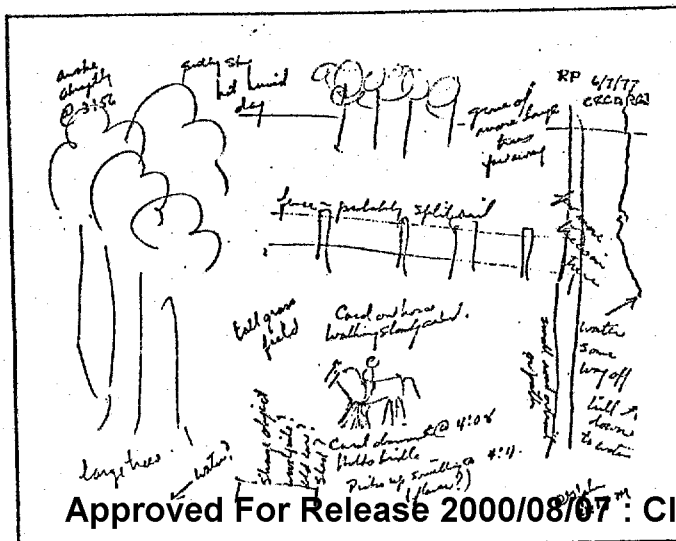
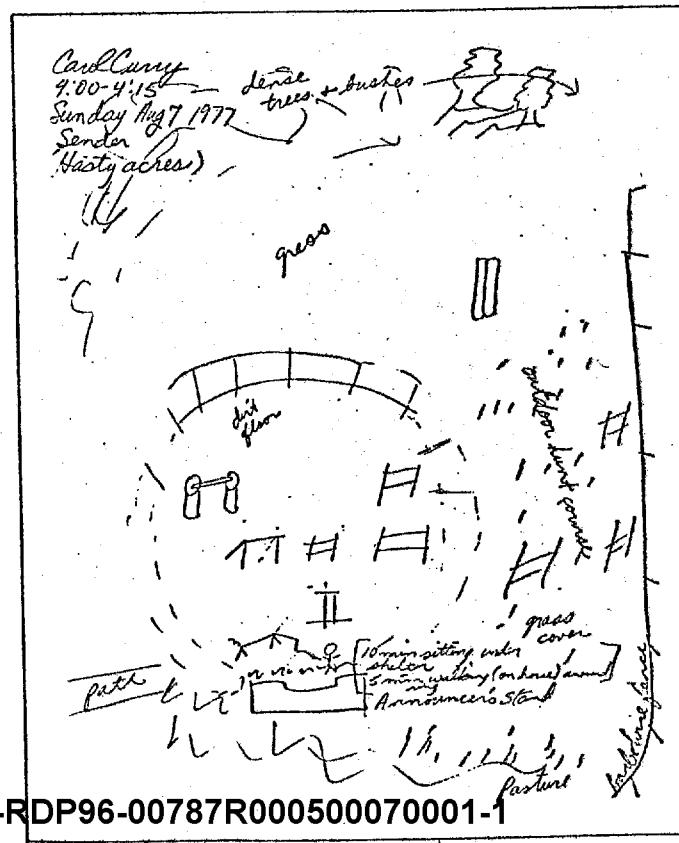


Figure 2

had drawn, but the typical show ring of white boards. The strange object in the foreground that I could not identify turns out to be the announcer's stand. Once again, we have a curious inversion: Carol noted that she spent ten minutes sitting under the shelter and then five minutes riding the horse, whereas I had perceived her dismounting at roughly that time.

We have tried this type of experiment many other times with many other people. Almost always there is some correlation between the sketches, ranging from rough impressions of the central features to virtually complete identification of the full scene. Rarely are there total failures, but occasionally we experience quasi-failures that are at least as interesting as the more successful results. For example, there was the instance when, at the appointed time, I found myself jammed in a noisy room with twelve other people in a suburban home in northern New Jersey. Although I suspected this was an unattractive target for Carol, I dutifully sketched the interior details. I was disappointed when I saw Carol's sketch to find she had drawn an outside scene, until I noticed that it was an accurate repre-

Figure 4



sensation of the yard surrounding the house in which I was seated.

On another occasion our random target-selection process directed me to a very damp, cold, dark, unpleasant place. Carol, confined in an office at SRI, again sketched an outdoor scene: the front of the chapel, complete with its arches, the correct number and disposition of steps leading up to it, and the identification of the patio as having gray and pink stones, precisely three feet square. This "near-miss" effect also appeared when we reversed roles: on our next attempt, Carol, as outbound experimenter, was directed by the same random protocol to a local "Holiday Inn" and there stood inside at the swimming pool near a pleasant flower garden. Back at the SRI laboratory, I sketched an accurate simulation of the entrance of the inn, complete with its large eucalyptus trees, a circular turn-around for the cars, the embankment of the highway, and other details.

To compound the mystery of remote viewing, we have further convinced ourselves that it is not necessary to perform the process in

real-time. That is, the percipient can acquire his information about the target site hours or even days before the outbound experimenter reaches, or for that matter selects, the target.²⁶

Attempts are currently being made to refine remote viewing techniques to permit transmission of information in terms of binary choices: regardless of the details of the scene, can the percipient identify, for example, whether it is dark or light, wet or dry, cold or hot, inside or outside, basically man-made or natural, etc.²⁷ If questions could be found which can be answered routinely with reasonable accuracy, it would be possible to transfer quite a bit of quantitative information this way.

We encourage you to try this remote viewing experiment for yourself: you may be surprised by what you can achieve. It seems to require little more than an open mind and a devil-may-care attitude to succeed, at least to a degree. For us it has been not so much a main interest as a credibility exercise and fascinating diversion, but it has encouraged us to try something considerably more ambitious.

The Geometry and Geography of Psychic Research

IN A FIELD as poorly comprehended and controversial as this one, it is rather difficult to construct any tidy organizational chart, but in the table below we have tried one possible outline using the prevailing nomenclature. The two dominant subdivisions of psychic phenomena (psi [Ψ]) are *extrasensory perception* (ESP) and *psychokinesis* (PK). Extrasensory perception refers generally to the acquisition of information from sources blocked from ordinary perception. Under this category are the subdivisions of *telepathy*, which refers to detection of another person's thoughts; *clairvoyance*, which refers to contemporary perception of physical objects or events; *precognition* and *retrocognition*, which refer to perception of future events and events in the past not accessible by normal recollection; and *animal ESP*, which encompasses a variety of seemingly inexplicable capabilities, such as homing, psi-trailing, collective consciousness, communication, etc.

Psychokinesis (alternatively termed telekinesis, or psychoenergetics) refers not to perception, but rather to a palpable disturbance of, or interaction with, a physical or biological system. The interaction may be deliberate or spontaneous, and the energy transfer involved may range from microscopic disturbance of atomic-level processes, through macroscopic distortion or levitation of objects, up to some very drastic and dramatic "poltergeist" effects. Psychic healing and man-plant interactions would be two examples of psychokinesis in biological systems.

For completeness, our table also lists other domains of psychic research not discussed in this report, such as life-after-death or so-called "survival research," and the family of "out-of-body experiences," which includes astral projection, autoscapy, and bilocation.

Categories of Psychic Phenomena

- I. Extrasensory Perception (ESP)
 - A. Telepathy
 - B. Clairvoyance
 - C. Precognition/Retrocognition
 - D. Animal ESP
- II. Psychokinesis (PK)
 - A. Physical Systems
 1. deliberate
 2. spontaneous
 - B. Biological Systems
 1. psychic healing
 2. plant PK
- III. Survival
 - A. Reincarnation
 - B. Apparitions
 - C. Mediumship

THE LIST below, by no means complete, shows locations at which psychic research is being done in the western world, including universities where one or more members of the faculty are, or recently have been, involved in the field to some degree; research institutes, some of which are solely concerned with psychic experimentation, and others of which are components of much larger enterprises; and two U.S. industrial corporations which have authorized publication in this field.¹⁸⁻¹⁹

We have made little attempt to survey foreign work, although there is significant research in England, France, Germany, the Netherlands, Scandinavia, and a major effort in the Soviet Union and other eastern bloc countries.²⁰⁻²⁴ Nor have we made any effort to cover Far-Eastern psychic activities, such as the traditional mysticisms of India and the Orient.

Psychic Research in the Western World

I. Colleges and Universities

Chicago	U.C./Los Angeles
Colorado	U.C./Santa Barbara
Columbia	Virginia
CUNY	Wisconsin
Drexel	Yale
Duke	Foreign
Harvard	Cambridge
John F. Kennedy	Edinburgh
Kent State	London
Mundelein	Oxford
New School for	McGill
Social Research	Paris
Pittsburgh	Freiburg
St. John's	Tel Aviv
St. Joseph's	Amsterdam
U.C./Berkeley	Utrecht
U.C./Davis	Lund

II. Research Institutes and Centers

American Society for Psychical Research, New York
 Ballistic Research Laboratories, Aberdeen, Maryland
 Center for Parapsychological Research, Austin, Texas
 Foundation for Research on the Nature of Man, Institute for Parapsychology, Durham, North Carolina
 Menninger Foundation, Topeka, Kansas
 Maimonides Medical Center, Brooklyn, New York
 Mind Science Foundation, San Antonio, Texas
 Psychical Research Foundation, Durham, North Carolina
 Science Unlimited Research Foundation, San Antonio, Texas
 SRI, International, Menlo Park, California
 Forschungsinstitut für Psychotronik, West Berlin

III. Corporations

Airesearch Company of California

AT THIS POINT Carol made a second suggestion — one with which I disagreed at the time — namely, that for our own studies we should concentrate on psychokinesis. I felt that the difficulty of this type of experiment, as I understood it, probably exceeded our abilities and that we would spend our time futilely trying to generate effects. As has been the case on more than one occasion in this project with her, I was wrong.

Why psychokinesis? Well, if the effects could be produced, as engineers we would enjoy a number of comparative advantages in their study. First, in contrast to other areas of psychic research, PK involves interaction with physical systems, and we are more at home with them than with biological or psychological processes. That same feature makes it possible to deal with a little harder form of data, and to quantify results a bit more precisely than when dealing with psychological or biological phenomena. Also, in this area our heritage of diagnostic and experimental equipment, data processing techniques, and analytical methods should serve us well. More specifically, the PK experiments, and the models we use to represent them, frequently involve the confluence of several basic sciences, and we are accustomed to that situation in more conventional engineering tasks.

As a further advantage, there has been much less controlled work in psychokinesis than in many other areas of psychic research, and therefore the experiments can be relatively simple at this point. In fact, those we have tried have all been assembled with off-the-shelf equipment available in our engineering laboratories. Finally, there is the intriguing possibility that PK may have some relevance to the general understanding of energy conversion, a topic of prime contemporary engineering concern.

As mentioned in the box on "Geometry" (page 4), it is helpful to divide the field of psychokinesis according to the magnitude of energy transferred. For example, there are the so-called macroscopic PK effects, such as the spoon-bending exercises of Uri Geller,^{27, 28} the salt-shaker levitations of the Russian woman, Kalagina,²⁹ and the self-levitations of the Frenchman, Girard.²⁹ These have been very highly publicized, but to the best of our knowledge have evaded well-controlled, systematic experimentation.

Then there are PK experiments which involve much smaller amounts of energy transfer, where the effects are made evident by an inherently high gain in the experimental design itself. For example, magnetometers normally used for the detection of weak magnetic fields are very sensitive to slight displacement of their spools;²⁷ certain types of torsional pendula can transcribe infinitesimal forces into measurable deflection of a light beam;³⁰ electronic strain gauges routinely used for measuring propagation of elastic and plastic waves in solids can be used to detect very small disturbances of solid objects.²⁸ Most of the experiments we have tried fall in this class and are described below in a bit more detail.

Next, there is the so-called microscopic PK domain, where one is attempting to intervene at the atomic or nuclear scale of a physical system: to influence a radioactive decay process, for example, or the emission of an optical photon, or the atomic collision processes in a gas discharge.³¹ These are the sorts of processes involved in most of the random generator devices, one version of which Carol designed and built for her independent work, as also described below.

Poltergeist Phenomena

Finally, there are the very rare and spectacular poltergeist effects, more technically termed "recurrent spontaneous psychokinesis (RSPK)." For years these phenomena were naïvely attributed to manifestations of the spirit world, or return of the dead to "haunted" houses, and inspired countless horror movies and pulp-magazine articles. Recently, some order has been brought to this bizarre business by systematic surveys of documented poltergeist cases by J. G. Pratt,³² W. G. Roll,^{33, 34} and others.³⁵

In one of these surveys, for example, 116 cases of poltergeist activity, reported from 1940 to 1960, were found to be associated with particular individuals living in the house, the mean age of whom was only 15 years. The majority



Dean Jahn and Carol Curry '79 with dual-thermistor experiment

of them suffered some debilitating ailment, usually of an emotional/neurological variety, most commonly epilepsy, although other diseases were also found. Often a precipitating event could be identified which seemed to initiate the activity. The general pattern involved a period of relatively mild precursor events, a sequence of major disturbances, and a period of "after shocks," extending as much as several weeks after the main events.

A typical case, reported at the 1977 annual meeting of the Parapsychological Association, occurred in the town of Pearisburg, Virginia, in December 1976. The precipitating individual was a nine-year-old foster boy who had been made a ward of the court because of his parents' alcoholism problems, and was living with a widow. Two weeks of precursors were experienced, such as flower pots falling off shelves at random intervals. During the major sequence (when the boy was in bed) pieces of fruit tumbled off a window ledge; the Christmas tree in the living room fell over; several of the kitchen cabinets turned onto the floor; an old Singer sewing machine was completely inverted; a rocking chair tumbled over backwards; and a carton of soda bottles was transported several feet.

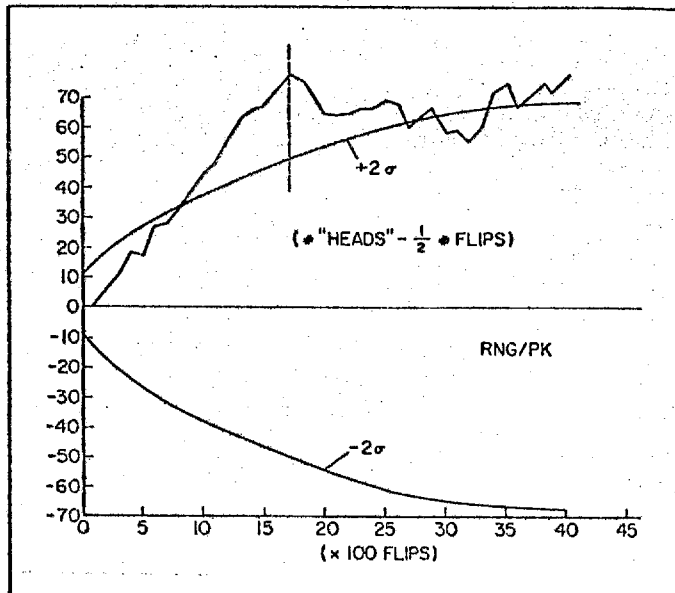
The widow called in succession her neighbor, her son who lived several miles away, and the local police — who in turn contacted a team of researchers from the University of Virginia Medical School who were on call for such poltergeist events. (Their report formed the basis of the paper presented at the meeting.)³² To conclude the story briefly, the widow was sufficiently distraught that she eventually left the house. She returned a week later with the boy to try to collect some belongings, and shortly after re-entering the house, similar activity began again. They quickly returned to her son's house, and there, on Christmas Eve, experienced another set of disturbances. With that, the boy was placed in another foster home, and no further record has been presented.

The point of including all of this is simply to note that while most psychokinetic investigations are straining for very small amounts of energy transfer — the disturbance of a photon, of an atomic nucleus, at best of a very sensitive magnetometer — here we find energy transfer of a very large magnitude. To invert the sewing machine, for example, would have required much greater physical strength than this boy could have exerted deliberately. Sooner or later, this must be dealt with in whatever models are proposed for psychokinesis.

Obviously, one would like to have a captive poltergeist agent — a person capable of precipitating this sort of activity on demand — but that is not likely to happen. Such agents seem unaware that they are involved in the process; to them the event is more like an epileptic seizure than anything they can consciously control. Further, the medical research in these cases, given the degree of emotional distress normally prevailing,

FOR THE MANY reasons cited, we have confined our first attempts at PK experiments to the microscopic and low-level macroscopic domains. For example, as part of her junior independent project, Carol worked on the design, construction, and operation of a random-event generator. She has had a certain amount of experience with equipment of this sort; in fact, she has been able to influence similar devices at SRI, at Schmidt's laboratory in San Antonio,³¹ and at Morris's laboratory at the University of California, Santa Barbara.³⁶

Figure 5



Experimental data from a random-event generator, an electronic device that simulates a rapid succession of "coin flips." The plot displays a significant excess of "heads" during a PK effort (the first 1,700 flips), after which the subject relaxed her attention, and the results reverted to normal, random behavior.

A record of one such experiment is shown in Figure 5. The device involved here is based upon a radioactive decay process, and essentially makes random binary choices — i.e., flips a coin — very rapidly. Actually, it makes 100 "flips" in a split second, and then displays how many of these turn out "heads." If the device were governed purely by chance, the cumulative total of many hundreds of flips should progress somewhere near the center horizontal line on the figure. Departures from chance would drive the cumulative data away from this "50-50" line. The parabolic lines sketched on the figure correspond to envelopes of departure by two standard deviations in the "heads" and "tails" direction. The actual results are plotted as the jagged line. As you can see, at the start of the experiment, these departed in a drastic, almost linear fashion from the random-chance line. In fact, of the first 18 groups of 100 flips, 17 yielded greater than 50 "heads." At that point, Carol ceased her effort, and the data abruptly transposed to a stochastic horizontal trace characteristic of normal chance.

Carol's current project is an attempt to repeat this sort of experiment with equipment she is building herself, with certain modifications which we think will be helpful.³⁷ In particular, she has modularized the device to see if we can determine which section is the most vulnerable to PK interference. Her machine consists of a random noise source, some logic circuitry which takes the random signal, samples it appropriately, and converts it to a binary signal; and a display unit which counts all

positive bits and indicates the total. One question the device may help clarify is this: when one interfaces with such a system, is it with the random source, with the logic circuitry, or with the display, or is this even a meaningful question? At present, we have only some baseline data and a few isolated PK results. For her senior project, Carol is refining the equipment using micro-processor technology, whereby data may be much more rapidly accumulated and processed.

We have also set up a few experiments of the high-gain variety, each characterized by a simple physical system which has an inherently large response to a very small disturbance. Such systems can readily be conceived and implemented in a variety of domains: mechanical, thermodynamic, fluid dynamic, electrical, optical, chemical, nuclear, etc. For our first attempt, we chose to replicate an experiment using thermistors that was performed by Gertrude Schmeidler and the psychic Ingo Swann at the City University of New York a few years ago.³⁸ Two of these very sensitive thermometric devices — each in its own vacuum bottle and surrounding insulation — are tied into a precisely balanced electrical bridge, and we observe the differential output. In other words, the two thermistors are bucking each other, and when this system is properly balanced, it yields a null signal if both are at the same temperature. The task of the subject is to attempt to make one of them increase or decrease its reading with respect to the other.

Again with the warning that this is a preliminary experiment, Figure 6 shows one set of data we obtained. On the chart record, time progresses vertically and the temperature differential horizontally. The best we could do at this particular time in balancing this very delicate bridge was to get a baseline signal like the three bottom traces, in which the indicated temperature difference wandered slowly to one side or the other, in this case to the left. Here our PK effort was to reverse the drift, and as you see, the top trace indeed progressed to the right for some time until we "relaxed," and then it resumed its leftward course. We have seen similar departures, indicative of an apparent change in the temperature of one of the thermistors by a few thousandths of a degree, on several other occasions; these changes are not particularly reproducible in magnitude or in sign, but hardly ignorable, either. Obviously, we would like to have a more stable baseline to work from, which is the goal of our current efforts with this experiment. Figure 7 shows a more recent result, less drastic than that in Figure 6, but with much better baseline stability.

Two chart records of the dual-thermistor experiments: In an early trial (Figure 6), the natural tendency of the bridge signal to drift to the left (lower three traces) was reversed by a PK effort (top trace). In a later run (Figure 7), a much more stable circuit responded with a change in signal character and a permanent displacement of the baseline to the left.

Figure 6

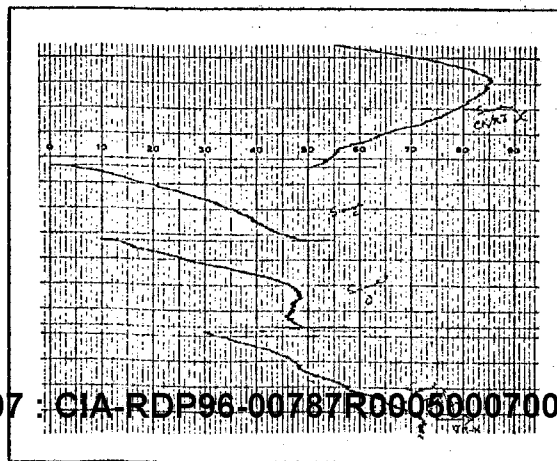


Figure 7

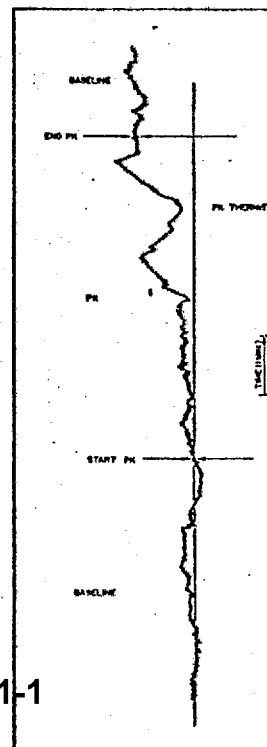


Figure 8

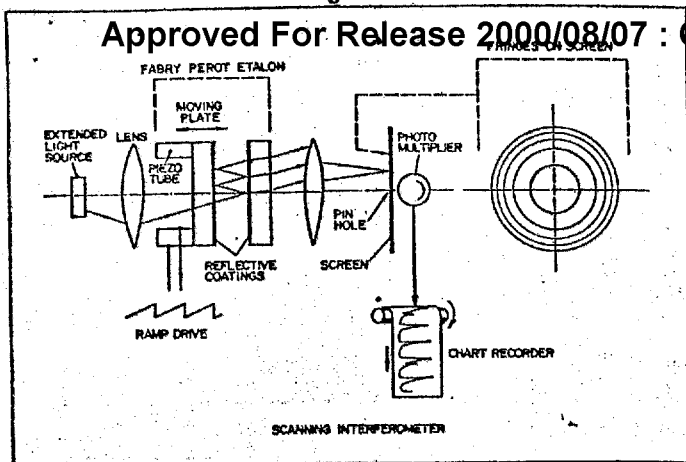


Figure 9

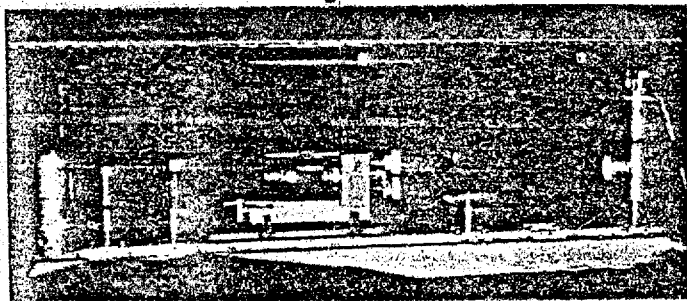


Figure 10

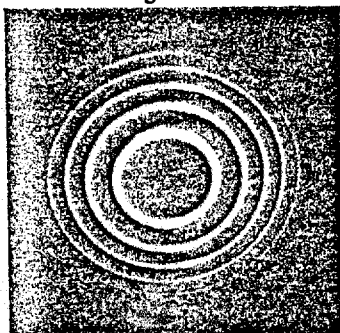
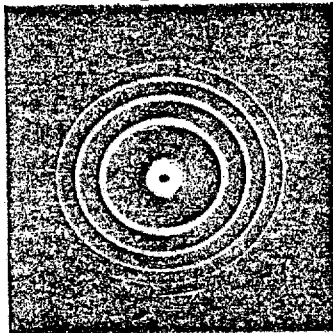


Figure 11

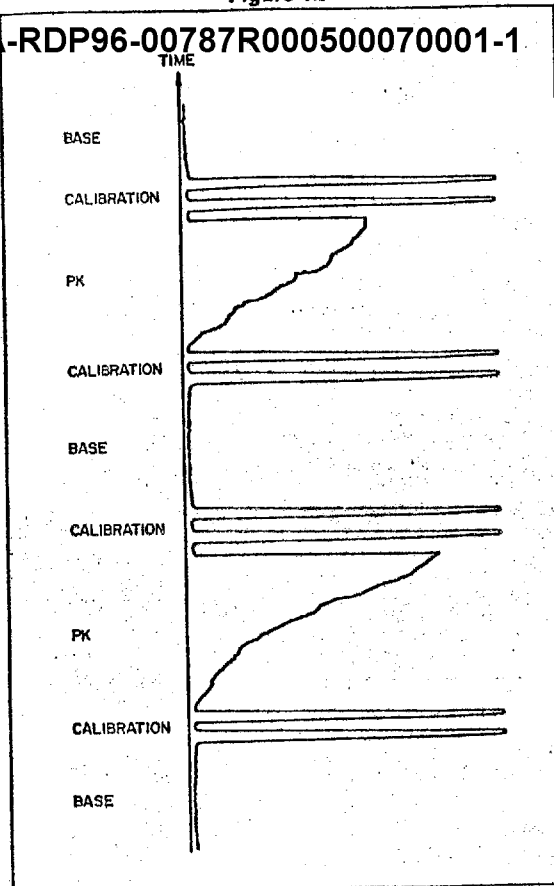


Another experiment takes advantage of a very high precision interferometer, a so-called "Fabry-Perot" device, which provides very sharp and attractive circular optical fringes. Figure 8 shows a schematic of this instrument (photographed in Figure 9), the central element of which is a pair of circular glass plates with highly reflective coatings on the two inner-facing surfaces. Light from the source on the left reflects between these mirrors several times and emerges in a state of interference with itself, producing a set of circular optical fringes on the screen. A small aperture in the middle of the screen permits the intensity of the central fringe to be detected by the photomultiplier, whose signal is displayed on a chart recorder.

From a PK standpoint, the sensitive element of this device should presumably be the optical plates. If they are separated slightly, the fringes propagate radially outward, and the central fringe changes from dark to light to dark in succession. Displacement of the plates of less than one millionth of a centimeter can be readily detected as a change in brightness or position of a given fringe. We normally set a black central fringe, as shown in Figure 10, and attempt to force the plates apart to produce a bright fringe in the center, as shown in Figure 11. When that happens, the photomultiplier shows a corresponding increase in output from its minimum to its maximum signal.

Figure 12 is a representation of one of our photomultiplier records. Time increases upward on the chart, and the initial segment of the trace shows the baseline black central fringe. Using remote control, the central fringe progresses through successive dark and bright illuminations, and the recorder swings correspondingly from the left baseline to its

Figure 12



The Fabry-Perot Interferometer, shown schematically (Figure 8) and photographically (Figure 9), produces a pattern of concentric optical fringes, the geometry of which is dependent upon the degree of separation of its two reflective plates. As the distance between the plates increases, the annular rings progress outward and the central fringe alternates steadily between dark (Figure 10) and light (Figure 11). The chart recording (Figure 12) shows variations in the intensity of the central fringe through a succession of instrument calibrations, baseline determinations, and PK efforts to increase the separation of the plates.

maximum excursion to the right, and returns. After this calibration, we begin the PK effort and are rewarded by a transition from central dark to almost full bright — something like four-tenths of a fringe change, which corresponds to some 10^{-5} cm displacement of the plates.

We again tune the instrument, run another fringe calibration, and then leave the device undisturbed to get a second baseline. Another retune and calibration are followed by a second PK effort, this yielding slightly less displacement than the first, and a final tuning, calibration, and baseline check. Very similar sequences of responses, with the PK segments contrasting sharply with the baselines, have been obtained on several occasions, but by no means have we been successful on all such attempts.

Beyond the incomplete reproducibility of this experiment, it also suffers from some possible ambiguity in the details of the interaction — e.g., one might conceivably claim that the influence is not on the plates, but on the index of refraction of the air between the plates, or even on the wavelength of the light source. It is our hope eventually to implement independent determinations of the plate separation and light frequency to resolve such questions.

One other experiment, which has just been put into a form where we trust the baseline operation, involves the spontaneous decay of a phosphorescent surface. Luminous phosphors, similar to those on wristwatch dials and television tubes, have a variety of decay times. Some last for seconds or fractions of seconds, depending on the particular substance. The radiation of the phosphor used in our experiment emerges from a

Figure 13

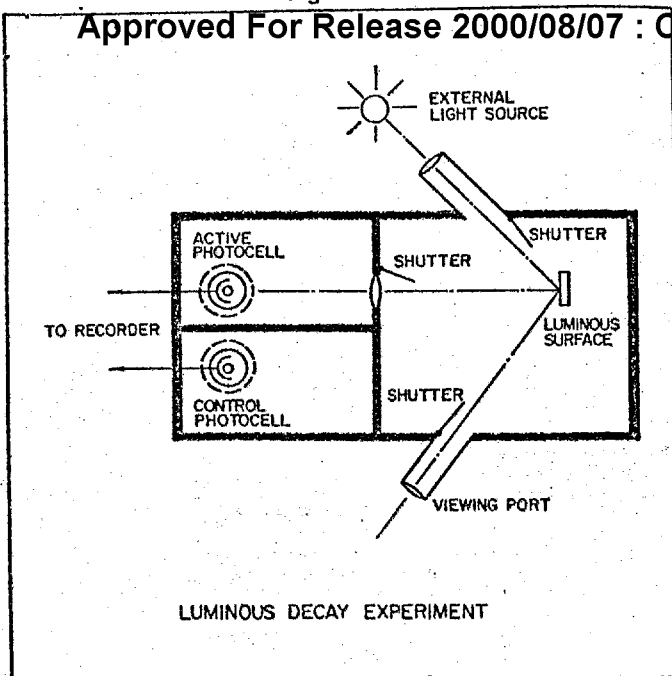
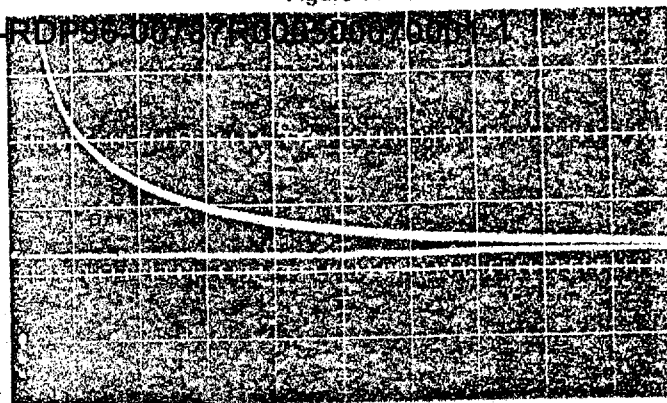


Figure 14



The luminous decay experiment, sketched schematically in Figure 13, yields photocell records like that shown in Figure 14. The task of the subject is to increase or decrease the rate of decay of the luminosity on command.

forbidden transition of an atomic electronic configuration from a metastable triplet to a singlet state.³⁹ Its decay time is about five minutes.

As indicated in Figure 13, the phosphor is initially illuminated by a germicidal lamp. We then observe the spontaneous decay of the phosphorescence with a photomultiplier, which yields the roughly exponential response shown in Figure 14. (This is an overlay of five such events, so we have some confidence in its reproducibility.) Our next task will be to attempt PK interference that causes the decay process to speed up or slow down, on demand.

We have several other ideas for high-gain PK experiments that have not yet been implemented. These involve delicately resonant mechanical devices, finely tuned electrical circuits, microwave resonators, transition of a fluid dynamic jet from laminar to turbulent flow, chemical reactions of very precise inception times, atomic "clocks," nuclear resonances, and others. By studying many of these, we hope not only to be able to select the most stable, reproducible, and effective devices for PK demonstration, but also to identify common aspects of the interactions that may help in the general comprehension of the process.

The results we have in hand are typical of the experience of others in this field: i.e., we find suggestive anecdotal effects on isolated occasions; but routine reproducibility has not been achieved. Experiments that work well on one day work less well, or fail to respond at all, on the next, under apparently identical conditions. By the standard criterion of scientific reproducibility, therefore, the effects ap-

pear spurious; yet in the context of a given experimental protocol, they are classically inexplicable.

At about this point in any of our presentations, the questions inevitably arise: What is the ambiance of a successful PK experiment? What is the strategy of the experimenter? How does it feel to influence the device? Regrettably, there seem to be no simple or general answers. The experimenter's interaction with a physical system is a highly personal, subjective, delicate, and elusive experience that defies articulation in straightforward terms.

The closest analogy I can find — and it is an imperfect one — is with the biofeedback process, wherein the patient is led to a degree of control over certain physiological functions via a monitoring system that displays his success, or lack of it, in the desired effort. So in PK, the behavior of the display unit — whether it be a set of illuminated numbers, the needle on a chart recorder, the position of optical fringes, or any other indicator — leads the experimenter to select out of his conscious and subconscious repertoire of attitudes those which happen to be productive at the time for the task at hand.

Many of the gifted psychics we have met, far more effective than we at PK, speak in abstract terms of "resonance with the system," "becoming an element in the system," "holistic attitudes," "global views," and "protoplasmic levels" — none of which acquires meaning short of the subjective experience of a given experimenter in a specific task. The problem of instructing a person in PK, I suspect, is akin to that of instructing him how to create a work of art.

Theoretical Models of Psychic Phenomena

BYOND THE introduction of more sophisticated measuring and data-handling techniques, the second recent development which holds some hope of leading psychic research out of the dark ages is the growing interest of a number of theoretical and applied physicists in formulating models of the processes. We would need an entire article to represent any one of these models adequately, and the cursory listing that follows can do little more than indicate their existence, and the breadth of the various approaches.

One of the earliest physical models to be proposed invokes very-low-frequency electromagnetic waves, of the order of 10 hertz (10 cycles per second), as the carrier of psychic information. In this approach, classical electricity and magnetism and information theories are combined to compute the energy and information trans-

fer attainable in this mode. The low-frequency range is reflective of certain biological frequencies — e.g., electrical potentials across the human heart, and many of the brain potentials, which could provide the mechanisms for launching and receiving these waves in the human physiology. In principle, this model should be experimentally testable, but in practice that is difficult because at these extraordinarily large wavelengths such effects as decay of the signal with propagation distance, diffraction and interference patterns, or attenuation in solid and liquid materials require almost global dimensions before becoming detectable. Identification of a speed of propagation of psychic information consistent with electromagnetic effects, but no experiments have yet established any definite velocity of propagation for psychic effects.

Somewhat similar wave propagation models have been proposed where information is communicated by means of electromagnetic communication.⁴² For example, infrasonic waves (sound waves of the same low frequencies) may carry information through the atmosphere, or signals may be modulated onto the static electric fields in the earth, the piezo-static fields arising from geoseismic activity, or the cloud-to-earth electric fields like those that develop in lightning storms. Similarly, magnetic anomalies of the earth may provide a base for such communication, a process studied in the context of the homing capabilities of birds.⁴³

Models based on the concepts of statistical thermodynamics have been attempted, with particular attention to the property called "entropy."⁴⁰ In essence, entropy is an index of the information content or, equivalently, of the degree of order of a physical system. For example, a large box containing many black marbles, all of which are to the left of its center, and many white marbles, all of which are to the right of its center, is a system of relatively low entropy: the arrangement of marbles is highly ordered, and one may with certainty extract a black marble by reaching into the left side of the box. If the box is steadily shaken, however, the black and white marbles will intermix and eventually achieve a random distribution. Now the operator has less information about the system: he cannot tell which color marble he will extract, no matter where in the box he reaches; the system now has higher entropy. Furthermore, its arrangement is highly irreversible, i.e., no amount of shaking is likely to return the marbles to their original, separated configuration.

The concept of entropy is by no means restricted to such mechanical situations. The unfortunate fate of Humpty Dumpty is an example of a drastic entropy rise of quite a different system. His demise from a highly organized whole egg to one that was completely scrambled was also highly irreversible. In living systems, the process of death and subsequent decay could be represented as a similarly irreversible process of entropy increase.

This natural tendency of complex systems towards states of disorder, which is formalized in the Second Law of Thermodynamics, is theoretically troublesome and esthetically unappealing in that it lacks a specifiable inverse process. That is, no mechanism for spontaneous reduction of entropy of an isolated system has been identified. Yet many manifestations of psychokinesis involve just such entropy reduction — a random generator which is caused to display an excess of high numbers, a torsional pendulum that changes from jiggling motion to a periodic oscillation, or the establishment of a temperature differential between two previously isothermal thermistors — all are proceeding toward more highly ordered states. Many of the Biblical miracles display similar characteristics: the parting of the Red Sea, the remote healing of the Centurion's servant, the raising of the dead, and, indeed, the creation of the universe itself are impressive examples of "spontaneous" entropy reduction. Question: what is the influence that drives such processes? Is it lurking somewhere in our established thermodynamic formalisms, or can an appropriate new ingredient be assimilated by them?

In a more mathematical vein, the general aspects of symmetry of our established physical theories are being re-examined in a search for previously rejected information.^{44, 45} We have been in the habit of taking only one class of solutions out of the differential equations of physics. The classical wave equation, for instance, yields both a retarded wave and an advanced wave solution, and we normally discard the advanced wave because "it does not conform to experience." This may be short-sighted; perhaps, for example, we could represent precognition in terms of advanced waves.

There are also several "hyperspace" theories which contend that our usual presumption of using only four coordinates to describe nature, three spatial and one temporal, limits our deductive capacity.⁴⁶ If we start all over again with five or six or seven, we may still extract the information needed for our traditional four-dimensional world, while in addition representing phenomena that would be regarded as paranormal on the basis of a strictly four-dimensional analysis.

Some of the most interesting attempts to model psychic phenomena make use of the formalisms of quantum mechanics.⁴⁷ The first class of scientific theory to depart significantly from strictly

deterministic representation of cause and effect in the physical world is quantum mechanics. Quantum mechanics deals with "probability densities" and "expectation values," which are in turn expressed in terms of wave functions or matrices rather than individual explicit quantities. One of the problems with which quantum mechanics has labored for years is that of experimental observation. It turns out not to be possible to observe any physical quantity or process without disturbing it in some way; the system inevitably reacts to any attempt to measure it. (Stated more formally, the quantum mechanical state vector of a system is not specified until a suitable measurement is made upon it.) This in turn leads to certain paradoxes, as epitomized in various famous examples, such as that of "Schrödinger's Cat," or "Wigner's Friend," or the "Einstein-Podolsky-Rosen Paradox." (The Wigner referred to is Princeton's Nobel Laureate and Professor of Physics Emeritus Eugene P. Wigner.)



"Every phenomenon is unexpected and most unlikely until it has been discovered — and some of them remain unreasonable for a long time after they have been discovered."
—Eugene P. Wigner, *Symmetries and Reflections* (1967)

After one concedes that the person conducting an experiment exerts an unavoidable influence on it, and in this sense becomes an integral part of it, the step to allowing a person to interfere in a deliberate way with a physical system is not quite so unpalatable. A number of attempts have been made to represent psychokinesis in this way. Some have invoked previously neglected "hidden variables" in the quantum theory to specify the human component. Others have made analogy of the synaptic transitions in the brain to quantum mechanical "tunnelling" processes, such as the escape of beta particles from radioactive nuclei.⁴⁸ All of this clearly involves a daring extension of mathematical physics to cover human characteristics.

In still another approach, it is claimed that psychic process can largely be assigned to inadequate comprehension of random physical processes.⁵¹ The central point here is that a truly random process is unattainable; all sources and all receivers in nature, because they are finite in dimension and finite in time, must show some departure from the truly random. That is, if enough correlations are examined, biases will prevail in those sources and receivers. The proposition, then, is that so-called paranormal communication is simply the resonant tuning of those very slightly biased sources and receivers. Left unexplained is the specific mechanism of the resonance, thus deferring the propagation problem to some other model.

Less analytical models propose empirical postulates for psychic functioning. For example, there is the proposition of "conformance behavior," which assigns to living systems the ability to influence the physical world to their own advantage.⁵² Some experiments have addressed this concept, employing human subjects, monkeys, goldfish, cockroaches, and even seeds.⁵³ Again, the details of the influence are not specified.

We shall make no attempt to review the many neurophysiological and psychological models that have been offered, first because we are not very well qualified to assess them, and second because we

have not seen any that help much with the physical side of the problem. **Approved For Release 2000/08/07 : CIA-RDP96-00787R000500070001-1** The left brain and right-brain perception capabilities. The left brain deals with the more analytic affairs of life; it is the part that deduces, interprets, counts, and reasons. The right brain, on the other hand, handles the more esthetic perceptions and sensations. Interestingly enough, those people who seem most adept at performing psychic feats tend to be right-brained; they are highly aesthetic and impressionistic in their thinking and articulation. The people needed to make sense out of it, however, are the analytical types who have the more highly developed left brain. Unfortunately, there is some evidence that each of these talents can interfere with the other. Those who are predominantly analytic seem less adept at psychic demonstration. For example, Targ and Puthoff have reported that people who have photographic memories are totally incapable of doing their remote-viewing experiments.²⁷

Applications and Implications

IF RESEARCH like that outlined above is eventually successful in advancing our understanding of psychic phenomena from simply bemused observation to some capability for more regular and controlled practice, then a wide range of applications can be seriously considered, involving an equally wide range of personal and social impact. For example, one can readily extrapolate from the present abilities of gifted psychics who can perceive remote scenes with remarkable precision, identify equipment and documents in sealed rooms, describe geographical features of a location given merely its map coordinates, and even now are called upon by police and rescue units to locate lost persons or objects. The extent and effectiveness of such applications clearly depends on the number and competence of people who can be found or trained to perform such tasks, which again raises the fundamental issue of what degree of psychic capability is latent in the human race, and susceptible to orderly development.

With regard to applications of psychokinesis in particular, the prognosis is even more clouded, pending more definitive basic experiments and serviceable theoretical models. Disturbing negative applications, such as interference with delicate technological equipment, jump to mind — and have concerned various public and private agencies.⁵⁶ More profound and significant, however, is the spectrum of potential personal applications whereby individuals might advantageously modify their immediate environment, and themselves, by this capacity. Already there is a small group of psycho-physiologists who feel that the early cognitive processes of control of body function — muscles, vision, blood flow, etc. — involve a significant component of trial-and-error self-PK, which by maturity has long since become routine and imperceptible. The practical distinction between this view and the more conventional models of infantile learning may not be of major consequence, but in matters of rehabilitation, some useful techniques might evolve.

Rather than belabor the unavoidably speculative applications *per se*, it might be better to turn to more general musing about the implications of psi, i.e., the effect on the individual, and on society, of such talents if they could be more broadly and routinely developed. From this point of view, there seem to be at least five levels of challenge:

First, there are the phenomena themselves, which, if valid, pose a very serious question, namely: are we facing a basic modification of our physical laws, or are we simply looking to identify new forces and new energy transfer processes to insert in the established physical formalisms?

Second, there is the level of personal discipline with which one must approach the field. One has to be critical enough to insist on rigorous fact, but not so stubborn that information is rejected because it does not conform to previous conceptions. One must distinguish between high vision and naïve delusion; between open-mindedness and gullibility.

Third, there is the level of the philosophy of the science, if indeed this is a science at all. If it is, it has some difficulties in representa-

It should also be emphasized that the absence of good neurological models of the psychic process does not in any sense imply that this component of the problem is unimportant. On the contrary, it underscores the difficulty of the entire modeling effort. As Laurence Veysey puts it: "The elusiveness of psychic phenomena is simply the elusiveness of the ordinary human mind."⁵⁴

Finally, there seems to be a growing suspicion that psychic phenomena may defy representation by any model drawn solely from a single domain of established science. In other words, psychic process may be fundamentally holistic, and any attempt to separate out the physical, biological, or psychological aspects, either in the experiments or in the theories, will inevitably obscure the phenomena. Should this indeed be the case, the analytical tasks become even more formidable, but this type of approach seems to be of growing importance in many other fields of scholarship as well.⁵⁵

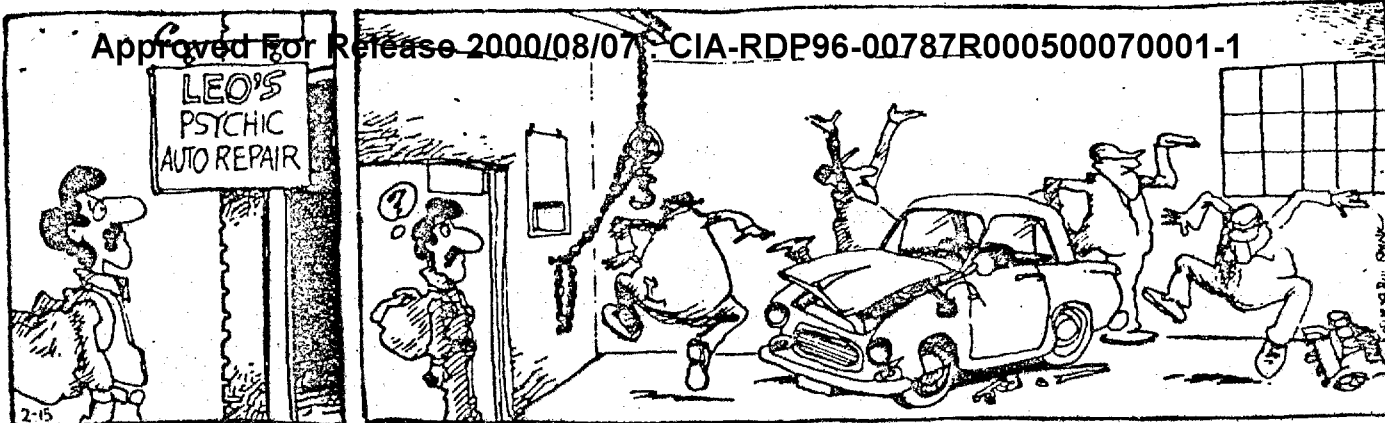
tion as such. How do you handle a "scientific" field which seems basically irreproducible, sensitive to the observer, evasive of close scrutiny, strongly goal-oriented, and heavily interactive with domains like theology and philosophy? In many respects psychic process seems as much akin to art, and music, and creative process in general as it is to analytical and replicable science. It has one foot in the esthetic and one foot in the analytic. It occupies an interface region like those Willis Harman has identified as the most urgent for society to develop if it is to extract itself from its present sociotechnological predicament.⁵⁷

The fourth level, once again personal in nature, concerns the individual "world-view" that derives. This was expressed rather well by our ex-astronaut, Edgar Mitchell, who has been for some time an advocate of this field, and who carried out psychic experiments on board his Apollo mission:

The profundity of the issue lies in the implications to our system of thought about the nature of man, the universe, and reality. In spite of the relative rarity of these events, the question must be asked, "Could it be that we, each one of us, everyday, by our thoughts are subtly influencing our environment, our reality, our Universe, without consciously knowing it, or is this type control strictly the province of a few rare individuals who possess this unique capability?"⁵⁸

Finally, there are the personal and collective reactions of others — the people to whom you try to explain all this, on an airplane, in a corporate meeting, in a sponsor's office, or in a report like this. What has been *your* reaction to this article? How much of a threat, or a challenge, has it been to you? Out of the sum of such reactions comes the sociological and political acceptance or rejection of the field. At present I suspect that the major portion of society still finds the business somewhat incredible, and hopes that it will quietly go away. But there is a minor fraction, possibly a growing fraction, which has a zest for this as a new frontier, and for whom the search for links between the mundane and sublime experiences of life have a numenistic appeal.

The present majority opinion does inhibit establishment of careful, disciplined research that could settle the issues of validity rather directly. As a consequence, the scholars and investigators tend to be a rather defensive and hunted group, in some cases actually persecuted by their peers for association with a field which admittedly has had more than its share of tawdry and fraudulent exploitation. For the same reason, the financial support of psychic research is minuscule; there is less spent on it per year in this country than the cost of one modern tank or one fighter aircraft. I had occasion to discuss this issue recently with a well-placed officer of the Department of Energy. Let me quote two sentences from a letter he sent me: The first says, "... As I have mentioned on several occasions to you and your staff, this subject is a personal interest to me ..." and later in the letter, "... but the national energy problem is an urgent one, and this type of activity may be seen as a dilution of some to be a dilution of our national efforts. ..."



Possible applications of psychokinesis: a cartoonist's view

Reflections

WHERE DOES all this leave us? At the start we promised a complex fabric of many implausible threads, and I think that has been fulfilled. Also sustained is our promise to advocate nothing, save possibly that we keep our eyes and minds and hearts open to this very new, yet very old, field. Certainly, the experiments are no more than suggestive, the models only vaguely promising, the applications and implications highly speculative. Ultimately, of course, the choice — and in a field such as this, it has to be a personal choice — must be between the assignment of all the inexplicable to mere chance, which is somehow bedazzling hyperromantic minds to delusion of order where there is none, or the acknowledgment of a legitimate, potentially coherent and useful, albeit very elusive, phenomenological domain.

Some 45 years ago, Albert Einstein confessed this same dilemma in his preface to Upton Sinclair's book, *Mental Radio*:

... The results of the telepathic experiments carefully and plainly set forth in this book stand surely far beyond those which a mature investigator holds to be thinkable. On the other hand, it is out of the question in the case of so conscientious an observer and writer as Upton Sinclair that he is carrying on a conscious deception of the reading world; his good faith and dependability are not to be questioned. . . .¹⁶

One might turn to historical analogies for insight, for there are certainly many examples of originally inexplicable phenomena gradually congealing into an established science and then into a useful technology. Take the field of electricity and magnetism mentioned earlier. At the same time the Greeks were consulting their Delphic Oracle, they were also rubbing amber to get static electrical effects, using lodestones to navigate their boats, and observing an occasional lightning bolt in the sky. They had no Maxwell's equations, not even a Coulomb's law, let alone television sets or hydroelectric generators. Those came much later.

Again at Princeton, the physicist Joseph Henry was repeatedly criticized by his peers for undertaking experiments that violated established scientific principles and common sense, yet we now live by many implementations of those same unreasonable ideas.

The choice between assignment of the mysterious to thoughtless chance, or to a more purposeful higher order, has occupied many thinkers and authors through the ages. One of my favorite opinions on the subject is voiced by Schiller's epic hero Wallenstein at the time of his impending tragic death:

Es gibt keinen Zufall; und was uns blindes Ohngefähr nur dünkt, gerade das steigt aus den tiefsten Quellen. ("There is no such thing as chance; and that which seems to us blind accident, actually stems from the deepest source of all.")¹⁹

Some day in the future the question may be posed whether it is proper and productive for a university such as Princeton to involve itself to any significant degree in so slippery, soggy, and suspect a

field as psychic research, and there will doubtless be many opinions on this. My own is not at all fully formed, but there has hung on my wall for the past six years a statement which may have some relevance at that time:

In the long history of civilization there are always strong pressures in favor of low-level sorts of conformity — pressures against unorthodoxy, individuality, and self-won responsibility. And all the while from left and from right aggressive voices proclaim that truth and virtue are theirs alone. But there is one place above all where it is (or should be) possible for men to think and act as their own reasoned judgment and best conscience dictate — namely, a university. Here it is that the willingness to think otherwise, to dream, to question, and to dare should flourish.

If an utter stranger to our civilization should ask: "Where in your society can a person disagree with impunity with accepted practices, dogmas and doctrines?" the answer should be, "The universities. That is part of their being. Their role is to conserve the best of the past and to look forward from it. On both counts they are committed to freedom for the individual, the dignity of the human person, and tolerance toward dissent within broad and agreed upon limits."

This is signed by the U.S. Ambassador to India and president emeritus of Princeton University, the Honorable Robert F. Goheen '40.²⁰

At the very least, Carol and I do hope that you have enjoyed sharing our own brief exposure to the psychic tapestry; that the colors have not been too garish for your taste, or the pattern too bizarre; and that some of you may now care to hold the cloth in your own hands, and attempt your own interpretation of its message. □

Robert G. Jahn '51, *55 has been dean of Princeton's School of Engineering and Applied Science since 1971. At the invitation of the Soviet Academy of Sciences, he visited several research centers in the U.S.S.R. this past fall to lecture on his principal field: pulsed, high-power plasma discharges, which are of interest for deep-space propulsion, plasmadynamic lasers, basic studies in arc phenomena, materials testing, and other industrial processes. He is a member of the University Research Board and serves as chairman of the Council on Environmental Studies, chairman of the Committee on Athletics, and faculty adviser to the football program. His extra-Princeton assignments include heading the Executive Committee of the Board of Trustees of Associated Universities, Inc. (the oversight and policy-making body for the Brookhaven National Laboratory and National Radio Astronomy facilities), as well as membership on a number of committees of NASA and the National Academy of Sciences.

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